DISHWASHER HAVING IMPROVED CONDENSATION MEANS

Inventor: James W. Jacobs, Dayton, Ohio
Assignee: General Motors Corporation, Detroit, Mich.
Filed: Nov. 30, 1970
Appl. No.: 93,692

FOREIGN PATENTS OR APPLICATIONS
1,255,254 11/1967 Germany..........................134/105
113,869 4/1945 Sweden............................62/331

Primary Examiner—Robert L. Bleute
Attorney—William S. Pettigrew, Frederick M. Ritchie and Edward P. Barthel

ABSTRACT
A dishwasher having an improved water condensation arrangement for use therewith including a dishwasher chamber having fluid circulating means together with means for providing a washing, rinsing and drying function in the compartment. A volatile fluid plate-type heat exchanger including continuous interconnected flow passages therein having a lower evaporator section in heat exchange relation with a wall of the chamber and an upper condenser section located in a cooling air duct between the chamber and the outer casing so as to be in heat exchange with a source of circulating cooling air to effect removal of moisture from the vapor in the dishwashing chamber to facilitate the drying of dishes within the chamber.

4 Claims, 5 Drawing Figures
DISHWASHER HAVING IMPROVED CONDENSATION MEANS

This invention relates to dishwashers and more particularly to improvements in or relating to the heat exchanger arrangement to effect condensation of water vapor in the dishwasher chamber.

In dishwashing apparatus cleaning chambers such as prior art U.S. Pat. No. 2,390,757 issued Dec. 11, 1945, it has been recognized as desirable to minimize the amount of steam or vapor which escapes to the area surrounding the dishwasher, by condensing the volatile fluid in the chamber and returning it to a liquid form to the sump portion, as a result of lowering the wet bulb temperature within the chamber and thereby facilitating the drying of dishes within the chamber.

In the design of dishwashers, as stated in my issued U.S. Pat. No. 3,068,877 dated Dec. 18, 1962, there are two drying systems which are prevalent, one wherein the access door for the dishwasher is opened at the beginning of the drying cycle and the other wherein the door is closed throughout the dishwashing cycle. Maintaining the door in a closed condition provides the advantage of reducing the exhaust of some of the steam from the dishwashing chamber and therefore eliminates some of the damage arising when condensate forms on the relatively cool surfaces of cabinets, countertops, etc., surrounding the dishwasher. The drying portion of a dishwashing cycle, however, is generally longer in those machines in which the door is closed during drying. It is the purpose of this invention to eliminate the problems of exterior condensation and to accelerate drying in a closed door drying system without having to materially modify the construction of the dishwasher cabinet or resort to an expensive separate motor-driven fan, etc.

Accordingly, it is an object of this invention to provide a dishwasher having a continuous volatile fluid heat exchange means for condensing moisture from the air within the dishwashing chamber.

It is also an object of this invention to provide a heat exchanger for dishwashing machines having a hermetically sealed closed circuit heat exchange unit of the plate-type construction having upper and lower sections interconnected by continuous flow passages adapted to contain a volatile refrigerant, the upper section of the heat exchanger being located in a vertical cooling air duct formed by spaced walls of the dishwashing chamber and outer cabinet, and adapted to operate as a heat dissipator or condenser while the lower section of the plate-type heat exchanger being in thermal contact with the dishwashing chamber and adapted to contain a liquid refrigerant to operate as a heat absorber or evaporator for cooling a portion of the chamber wall and thereby provide gravity flow of condensate to the sump of the dishwashing chamber.

Other features and advantages of the invention will be apparent from the following description of a certain embodiment taken in combination with the accompanying drawings, wherein a preferred embodiment of the present invention is clearly shown.

IN THE DRAWINGS

FIG. 1 is a generally schematic representation of a dishwasher incorporating the invention;
FIG. 2 is an enlarged front elevational view of the heat exchange plate of the present invention;
FIG. 3 is a cross-sectional view taken on lines 3-3 of FIG. 2;
FIG. 4 is a fragmentary cross-sectional view similar to FIG. 3 of a modified form of the heat exchanger plate;
FIG. 5 is a view similar to FIG. 4 of still another modification of the heat exchange plate.

In accordance with this invention and with reference to FIG. 1, a dishwasher 10 having an outer cabinet 11 including a top 12, side panels one of which is partially indicated at 13, a rear panel 14 and a base portion 16 adapted to include the dishwashing chamber shown generally at 18. The dishwashing chamber 18 is a generally box-like receptacle having a depressed bottom defining a sump 20. The dishwashing chamber 18 has also an access opening 22 in the front wall thereof above lower front panel 23. Closing the opening is a dishwasher door, shown generally at 24. The door 24 may be hinged and latched to the side panels of the dishwasher 10 in any conventional manner and is adapted to be operated by the handle 26. In order to ensure watertight connection between the dishwashing chamber 18 and the door 24 a gasket 28 may be provided in arranged periphery about the opening 22.

Although this invention is not to be limited to a particular type of dishwasher, for purpose of illustration the dishwasher 10 is shown provided with a revolving spray arm 30 located beneath a lower utensil support 32 and a spray column or tower 34 affixed to the spray arm and extending upwardly through a guard portion 36 of the lower rack permitting the removal of the lower rack from the dishwashing chamber. The spray column 34 is formed within a large bulbous housing or header portion 38 at the top thereof having an upper spray nozzle or outlet 40, aimed toward an upper utensil support 43 and upper chamber wall 443 together with a plurality of outlets or ports 44 around the periphery of the header 38. The reaction effect of the water sprayed from the spray arm ports 46 will cause the water distribution means, including the spray arm 30 and spray column 34 to rotate. The water distribution system is the type disclosed in the commonly assigned Braden et al. U.S. Pat. No. 3,292,645 issued Dec. 20, 1966, the disclosure thereof being incorporated herein by reference.

The water distribution system of the dishwasher 10 includes a pump assembly 50 driven by suitable drive means, for example, a reversible electric motor 52 disposed below the pump assembly in the machinery compartment 54. The pump assembly 50 includes the rotatable horizontal spray arm 30 thereon to which fluid is supplied from the sump region 50 for distribution through the washing chamber 18 during a cleaning cycle of the dishwasher as established by a sequence or timer control means 56 having a timer control knob 58 located on the front of the dishwasher door 24. Also within the dishwashing chamber 18 is a heater 59 which is selectively energized at the conclusion of the wash portion of the cycle to raise the temperature within the dishwashing chamber 18 to dry the dishes therein. It is of course possible to energize the heater 59 periodically throughout the washing portion of the cycle to maintain desired higher washing fluid temperatures within the chamber 18. At the conclusion of the dishwashing cycle, the motor is reversed to permit the pump 50 to remove water from the sump 20 to any suitable remote waste. The dishwashing cycle may be initiated by a start button to energize the timer which thus programs sequentially the desired dishwashing cycle. For additional details on the dishwashing mechanism outlines broadly hereinabove, reference may be had to the Braden et al. patent mentioned above.

During the period that water is being circulated from the sump 20 to the spray arm 30 and spray tower 34, considerable steam is involved depending, of course, on the temperatures of the washing fluid being circulated. When the surfaces of the dishes and utensils carried by the racks 32 and 42 have been sufficiently cleaned and rinsed, it is then desirable to effect a rapid drying of the cleansed dishes. If the door 24 closing the steam or vapor filled dishwashing chamber 18 were opened, steam and vapor thus released would flow into the surrounding area to condense on the first cool surface encountered. As explained in the above-mentioned U.S. Pat. No. 3,068,877, it is desirable to keep the door closed during the drying operation of the dishwashing cycle and applicant has provided a novel plate-type heat exchanger or dehumidifier generally indicated at 60 to be mounted on the back wall 62 of the chamber 18 for removing moisture from the vapor within the dishwashing chamber when the dishes are being dried.

The plate-type heat exchanger 60 is preferably of the roll-forged or roll-bonded construction, in which two sheets of metal 64 and 66, such as aluminum, are integrally welded together to form a single plate which has a plurality of
passages in the spaced walls forming volatile fluid horizontal and vertical passages or conduits and having the walls integrally joined together at a multiplicity of spaced points or welded areas indicated at 68 for supporting them in definite spaced relation. Such a plate-type heat exchanger is shown in developed plan in FIG. 2; and the two sheets from which it is formed are spaced from each other to form a charging opening 69 located on the right-hand edge in FIG. 2 and which is pinched closed and heliarc welded after charging with volatile fluid which in the preferred form is a refrigerant of the type having the designations R-12, R-22 or R-114 commonly known as Freon.

The heat exchanger is formed as a flat plate as shown in FIG. 2 and is bent on rounded curves as indicated by the fold lines A and B to provide an upper condenser plate section 70 and lower evaporator plate section 74 joined by intermediate bonded web section 72. As seen in the view of FIG. 2, the lower plate section 74 is provided with apertures 76 for mounting. In direct heat exchange contact with the lower region of the chamber wall 62 adjacent bottom wall 63 by suitable means such as bolts 78. The annularly offset intermediate section 72 extends away from the chamber wall 62 such that its upper plate section 70 is in a plane parallel to and offset from the plane of the lower plate section 74. As seen in FIG. 1 the upper plate section 70 of the heat exchanger 60 is mounted on spacer studs 80 extending through apertures 82 of the heat exchanger 60 adjacent the upper wall 43 of the dishwashing chamber such that the upper plate section 70 is substantially aligned in a vertical flue or duct 81 defined by the rear panel 14 of the cabinet and the back wall 62 of the chamber 18 so as to be substantially coextensive with the back wall 62.

The upper condenser plate section 70 is shown provided with a larger substantially rectangular refrigerant condenser passage portion 83 of the waffle-type construction having the charging opening 69, located in its upper right-hand corner of plate 70, leading to upper horizontal header passage 86, parallel to the series of horizontal passages 87 connecting the upper ends of vertical passages 88 which extend downward to the sloped header 89 provided for receiving the condensed liquid refrigerant. Sloped header 89 connects to a vertical liquid refrigerant passage 90 formed by the intermediate welded web 92 of section 72. The web 92 is shaped in the form of a parallelogram and has a welded extension 94 leading to the lower left-hand corner of plate 74 and connects to a lower horizontal header 96 of a lower waffle-type refrigerant evaporator passage portion of plate 74, designated by the reference character 98. An evaporated refrigerant connecting passage 99 is provided opposite the liquid refrigerant connecting passage 90 and extends vertically to the upper right-hand corner of condenser plate section 70 to connect to the upper header passage 86, by means of web extension 100, communicating with the upper waffle-type condenser portion 83. This arrangement provides good distribution of both the vapor and liquid portions of the refrigerant.

Cooling air is provided for the plate condenser section 70 from the atmosphere surrounding the dishwashing chamber 10. A cooling air louvered inlet 110 is formed in base portion 16 while an air outlet 112 is vertically spaced from the inlet 110 to permit the cooling air to return to the atmosphere after passing over the plate-type condenser 70 in duct 81. It should be noted that in a modified form of the invention an impeller 114, driven by motor 52 and an L-shaped duct wall 116 could be utilized in a manner as taught in applicant's above-mentioned U.S. Pat. No. 3,068,577 for example, to increase the flow of cooling air over the condenser portion 83 of the heat exchanger 60 if desired without departing from the scope of the invention.

In operation, the liquid refrigerant in the waffle-type portion 70 in the evaporator plate section 74 evaporates to cool the plate and in turn the lower portion of the chamber wall 62 which is in direct thermal contact therewith. The refrigerant vapor flows upwardly into the sloped header 106 and thence vertical passage 99 and into the waffle-type portion 83 of the plate condenser 70 which is at a lower temperature because of its spaced relation to the chamber walls 62 and exposure to the cooling air flow in duct 81. The cold junctions in the liquid refrigerant evaporates and extracts heat from the lower portion of the chamber wall 62 by means of lower plate evaporator section 74. The lower portion of wall 62 is thus below the dew-point of the vapor in the chamber and moisture will thus condense from the vapor and will fall by gravity to the lower wall 63 and consequently into sump 20 where it may be removed to drain by the action of a continuously or periodically operating pump 50. Of course, the pump 50 need not be operating throughout the drying cycle and the condensate may be permitted to run by gravity to drain, if so provided for.

By means of applicant's device the wet bulb temperature in the chamber 18 is lowered without affecting the dry bulb temperature to a significant degree. This can be shown by reference to a Bulkeley Psychrometric Chart wherein with a dry bulb temperature of approximately 120°F. and a condensing temperature of 90°F the relative humidity in the chamber would be of the order of 30 percent. A reduction of the web bulb temperature to 80° will reduce the relative humidity in the chamber to the order of 17 percent and a further reduction of the wet bulb temperature to 70°F. will reduce the relative humidity to something less than 5 percent.

A modified form of the upper condenser plate is shown at 118 in FIG. 4 wherein slotted louver 120 are formed in the welded areas 68 to increase the circulation of cooling air in the duct 81 to increase the rate of heat transfer from the waffle-like condenser portion 83 to the air. A still further modification of the upper condenser plate 70 is shown at 122 in FIG. 5 wherein L-shaped fins 124 are incorporated on the plate as by welding to increase the rate of heat transfer to the cooling air.

It will thus be seen that applicant has utilized the "heat pipe" principle to provide a gravity flow plate-type heat exchanger which operates almost isothermally. That is the volatile working fluid, which in the preferred embodiment is a liquid refrigerant such as R-12 (Freon-12), has a liquid temperature in the evaporation section within the order of one or 2°F. of being equal to the vapor temperature of the refrigerant in the condenser section. The result is that a near isothermal continuous heat transfer is accomplished wherein the relative humidity of the cleaning fluid entering the dishwashing chamber is decreased expeditiously the drying of the dishes.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is:

1. A dishwasher including walls enclosing a dishwashing chamber and defining an access opening, a door for enclosing the dishwashing chamber, means for spraying in said chamber, means for supporting dishes in exposed relationship to said spray means, one of said walls forming a sump below said support means and having a sump opening selectively connected to a drain, means connected to said sump opening for supplying cleansing fluid to spray means for spraying dishes in said sump support means whereby cleansing fluid sprayed on said dishes gravitationally returns to said sump, heating means for drying the dishes with said door closed by vaporizing the cleansing fluid on said dishes after the dishes have been sprayed, cooling air duct means adjacent said chamber, a closed volatile refrigerant heat exchanger having an upper condenser section positioned in said cooling air duct means in thermal relationship with said dishwashing chamber and a lower evaporator section positioned in direct thermal contact with said dishwashing chamber, a volatile refrigerant in said heat exchanger, said upper condenser section and said lower evaporator sec-
tion each having refrigerant flow passage means therein, first and second conduit means interconnected said condenser section passage means and said evaporator section passage means whereby a closed continuous recycling flow passage network for the refrigerant is established, said upper condenser section passage means adapted to contain said refrigerant in gaseous form to operate as a heat dissipator and said bottom evaporator section passage means adapted to contain said refrigerant in liquid form to operate as a heat absorber and cool said chamber wall for condensing moisture from said cleansing fluid vapor, said first conduit means providing a passage for said refrigerant in liquid form from said upper condenser section to said lower evaporator section, said second conduit means providing a passage for said refrigerant in gaseous form from said lower evaporator section to said upper condenser section, said refrigerant upon absorbing heat from the chamber wall rising in gaseous form in said second conduit means to said upper condenser section whereby the refrigerant is condensed back to liquid form for flow of said refrigerant by gravity through said first conduit means providing near isothermal continuous heat transfer such that the relative humidity of said cleansing fluid vapor in said chamber is decreased and the drying of said dishes is expedited.

2. A dishwasher including fixed top, bottom, rear and side walls enclosing a dishwashing chamber, a door for enclosing the dishwashing chamber, means for spraying in said chamber, means for supporting dishes in exposed relationship to said spray means, said bottom wall forming a sump below said support means and having a sump opening selectively connected to a drain, means connected to said sump opening for supplying cleansing fluid to said spray arm and said spray tower for spraying dishes in said support means whereby fluid sprayed on said dishes gravitationally returns to said sump, heating means for drying the dishes with said door closed by vaporizing the fluid on said dishes after the dishes have been sprayed, cooling air duct means adjacent a side wall of said chamber, a closed volatile refrigerant heat exchanger positioned in said cooling air duct means, said heat exchanger being of the unitary plate-type having interconnected refrigerant flow passages therein including a lower evaporator section, an intermediate section and an upper condenser section; said upper condenser section spaced from said chamber side wall and adapted to contain said refrigerant in gaseous form in its passages to operate as a heat dissipator to the cooling air in said duct means, said bottom evaporator section being in thermal contact with said chamber wall and adapted to contain said refrigerant in liquid form in its passages to operate as a heat absorber and cool said chamber wall for condensing moisture from said cleansing fluid vapor, said intermediate section providing a second vertical passage between said opposite side edge of said heat exchanger for said refrigerant in gaseous form from said lower evaporator section to said upper condenser section, said intermediate welded web forming a sloped header passage in said condenser section to provide gravity flow of said refrigerant in liquid form to said first passage, said refrigerant upon absorbing heat from said chamber wall rising as a vapor in gaseous form in said second passage to said upper condenser section such that said refrigerant is condensed back to liquid form for flow of said refrigerant by gravity through said first passage providing near isothermal continuous heat transfer such that the relative humidity of said cleansing fluid vapor in said chamber is decreased and the drying of said dishes is expedited.

4. A dishwasher including fixed top, bottom, rear and side walls enclosing a dishwashing chamber, a door for enclosing the dishwashing chamber, means for spraying in said chamber, means for supporting dishes in exposed relationship to said spray means, said bottom wall forming a sump below said support means and having a sump opening selectively connected to a drain, means connected to said sump opening for supplying cleansing fluid to said spray arm and said spray tower for spraying dishes in said support means whereby fluid sprayed on said dishes gravitationally returns to said sump, heating means for drying the dishes with said door closed by vaporizing the fluid on said dishes after the dishes have been sprayed, an outside cooling air duct partially formed between the back wall of said chamber and the rear wall of said dishwasher, a closed volatile refrigerant heat exchanger positioned in said cooling air duct between said chamber back wall and said dishwasher rear wall, impeller means in said duct for initiating a circulation of outside air flow through said duct, said heat exchanger being of the unitary plate-type and generally rectangular in shape having interconnected horizontal and vertically disposed refrigerant flow passages of the waffle-type wherein including a lower evaporator section, an angularly offset intermediate section and an upper condenser section bent in the plane of said bottom section so as to be spaced from said chamber side wall, said upper condenser section adapted to contain said refrigerant in gaseous form in its passages to operate as a heat dissipator to the cooling air in said duct, said condenser section having slotted louvers formed in the welded web areas between said flow passages to increase the rate of heat transfer from condenser section to the outside air flow in said duct, said bottom evaporator section being in thermal contact with said chamber wall adjacent said bottom wall and adapted to contain said refrigerant in liquid form in
its passages to operate as a heat absorber and cool said chamber wall for condensing moisture from said cleansing fluid vapor, said intermediate section providing a generally parallelogram-shaped welded web for the separation of the gaseous and liquid refrigerant, said intermediate section welded web having its ends substantially parallel with the vertical side edges, said heat exchanger providing a first vertical passage adjacent one side edge of said heat exchanger for said refrigerant in liquid form from said upper condenser section to said lower evaporator section, said intermediate section providing a second vertical passage adjacent the opposite side edge of said heat exchanger for said refrigerant in gaseous form from said lower evaporator section to said upper condenser section, said intermediate welded web forming a sloped header passage in said condenser section to provide gravity flow of said refrigerant in liquid form to said first passage, said refrigerant upon absorbing heat from said chamber wall rising as a vapor in gaseous form in said second passage to said upper condenser section such that said refrigerant is condensed back to liquid form for flow of said refrigerant by gravity through said first passage providing near isothermal continuous heat transfer such that the relative humidity of said cleansing fluid vapor in said chamber is decreased and the drying of said dishes is expedited.